Before The
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
	)	
Digital Television Distributed	)	MB Docket No. 05-312
Transmission System Technologies	)	
	)	

To: The Commission

Reply Comments of the Merrill Weiss Group, LLC

Summary

The Merrill Weiss Group LLC thanks the Federal Communications Commission (FCC) for moving forward with the Notice of Proposed Rulemaking (NPRM) on Distributed Transmission Systems (DTS) and offers the following comments in reply to those submitted during the original comment period that closed on February 6, 2006. While our initial comments attempted to address each and every question that the Commission posed in the NPRM, these comments are limited to addressing mostly technical and procedural matters in the hope that they will aid the FCC in reaching the decisions that it must in order to put into place rules for the routine authorization of DTS technology.

With few exceptions, those commenting in the proceeding favored the FCC's proposal to adopt rules enabling the licensing of DTS facilities and approved of the general approach proposed by the Commission regarding the specifics of such authorizations. Some commenting parties provided alternatives on specific topics, however, particularly with respect to service areas, variable interference ratios, interference calculations, and revisions to the interference analysis procedures contained in OET Bulletin Number 69 (OET-69). The comments of the Association for Maximum Service Television, Inc. (MSTV), Cohen, Dippell, and Everist, P.C. (CDE), and Harris Corporation are particularly relevant and are addressed in these Reply Comments along with a few other sets of comments.

Introduction

The Merrill Weiss Group LLC is a small consultancy practice focused on electronic media technology, technology management, and management in general. Over the past fifteen years, it generally has consisted of two or three individuals, one or two of whom have had decades of experience in the broadcasting and related industry segments. Since early 1991, the principal of the Merrill Weiss Group LLC has been working to develop the concepts and the technology of Single Frequency Networks (SFNs), which came to be called Distributed Transmission Systems during work on the subject by the FCC Advisory Committee on Advanced Television Service (ACATS), in particular, in the output of the Implementation Subcommittee, Working Party 2 on Transition Scenarios (IS/WP2).

In light of this experience and in an effort to find workable solutions for challenging service issues of a number of clients, the Merrill Weiss Group LLC presented a solution for DTS transmitter synchronization to the Advanced Television Systems Committee (ATSC) in the context of its efforts to enhance the 8-VSB transmission system that it documented and that the Commission adopted as the standard for digital television (DTV) broadcasting in the United States. The solution to the transmitter synchronization requirement involved invention of the technology necessary to overcome the inherent randomness of the 8-VSB signals. That technology ultimately was incorporated into the ATSC "Synchronization Standard for Distributed Transmission" (A/110A).

Why is this background information important as an introduction? It is necessary to understand the origins of the current proceeding to appreciate the misinformed nature of statements appearing in the comments of the New America Foundation, *et al* (NAF). There, this proceeding is characterized as essentially a spectrum grab by broadcasters, who are seeking to further enrich themselves through the use of DTS to overcome propagation and other technical challenges that previously have prevented them from providing full service to audiences within their markets. Nothing could be further from the truth. In fact, this proceeding began from an effort to find technical solutions to advance the Commission's goals of completing expeditiously the transition to DTV and of making DTV service available to the largest possible proportion of the U.S. population.

Indeed, after reviewing the NAF comments, the reader might be surprised to learn that the Commission's own Spectrum Policy Task Force (SPTF) saw the wisdom of the Distributed Transmission approach when it stated, in the Report of the Spectrum Efficiency Working Group, "in some services (for example, broadcasting), the Commission's rules prohibit the deployment of low power transmission networks. The Commission should consider changing its rules in this regard. It also may be appropriate to consider incentives that could promote the use of such technology." In the Final Report of the SPTF, it is recommended that the Commission take a number of steps to reduce interference, including "[p]romoting the use of advanced antenna technology and system design techniques that would enhance the uniformity of transmitted signal strength levels through a service area." Moreover, in two places in the SPTF Final Report, the recommendation is made to "[p]ermit high-power digital television broadcasters to operate single frequency low power distributed transmission systems…" It is just for such purposes that we initiated the DTS approach covered by the present NPRM.

Service Areas

The only significant policy issue subject to any real debate in this proceeding is the definition of the service areas that stations using DTS networks will be permitted to cover. To help the Commission identify possible decisional outcomes for this system characteristic, in prior comments, we have pointed out a number of potential choices. We have not expressed a preference for one or another of those choices but have endeavored to define their attributes to the extent possible. In the NPRM, the Commission put forth yet another possibility that we had not discovered, viz., a scheme using a fixed-radius circle centered on the reference point of each station. The radius used is that for a maximized theoretical facility in the frequency band and geographic zone in which a station is located.

Some commenters supported the Commission's proposed approach to the service area matter while the others who addressed the issue largely supported the DMA-based approach that we had described in prior comments. Whichever way the Commission decides to regulate DTS service areas, it is important that consideration be given to the subject of service to communities near the boundaries of the defined service areas. If the signal levels in the boundary regions are restricted to levels near the noise limited threshold (e.g., 41 or even 48 dBu at UHF), then communities in those areas will be forever consigned to third-rate service. This result will obviate one of the real potential benefits of DTS implementation, i.e., the delivery of more uniform signal levels throughout a service area. Thus, it is important that the Commission make provision for increased signal levels in boundary regions while simultaneously putting limits on where service can be provided.

Perhaps an example will help to make the boundary service issue clear. In Figure 1, the noise limited contour of a maximized facility is shown in orange. The 103 km circle from the proposed Table of Distances is shown in black. The noise-limited contour of a lower power distributed transmitter is shown in purple. The field strengths predicted by the Longley-Rice propagation model are shown in a variety of colors extending from yellow (strongest) to cyan (weakest – just at or slightly above the noise limited threshold). As can be seen in the figure, the predicted signal coverage is severely restricted by mountains on either side of the city to be served, which happens to be located in a valley that makes reception from the maximized facility virtually impossible. It also happens that the DMA of the market has its boundary (shown in dark blue) at the county line immediately adjacent to the city to be served. As can be seen, the contour of the DTS transmitter extends beyond the DMA boundary and well beyond the service contour of the maximized facility, yet the predicted service is largely inside both the DMA and the maximized facility service contour (which extends somewhat beyond 103 km from the maximized transmitter but is comparable to the size of the circle from the Commission's proposed Table of Distances).

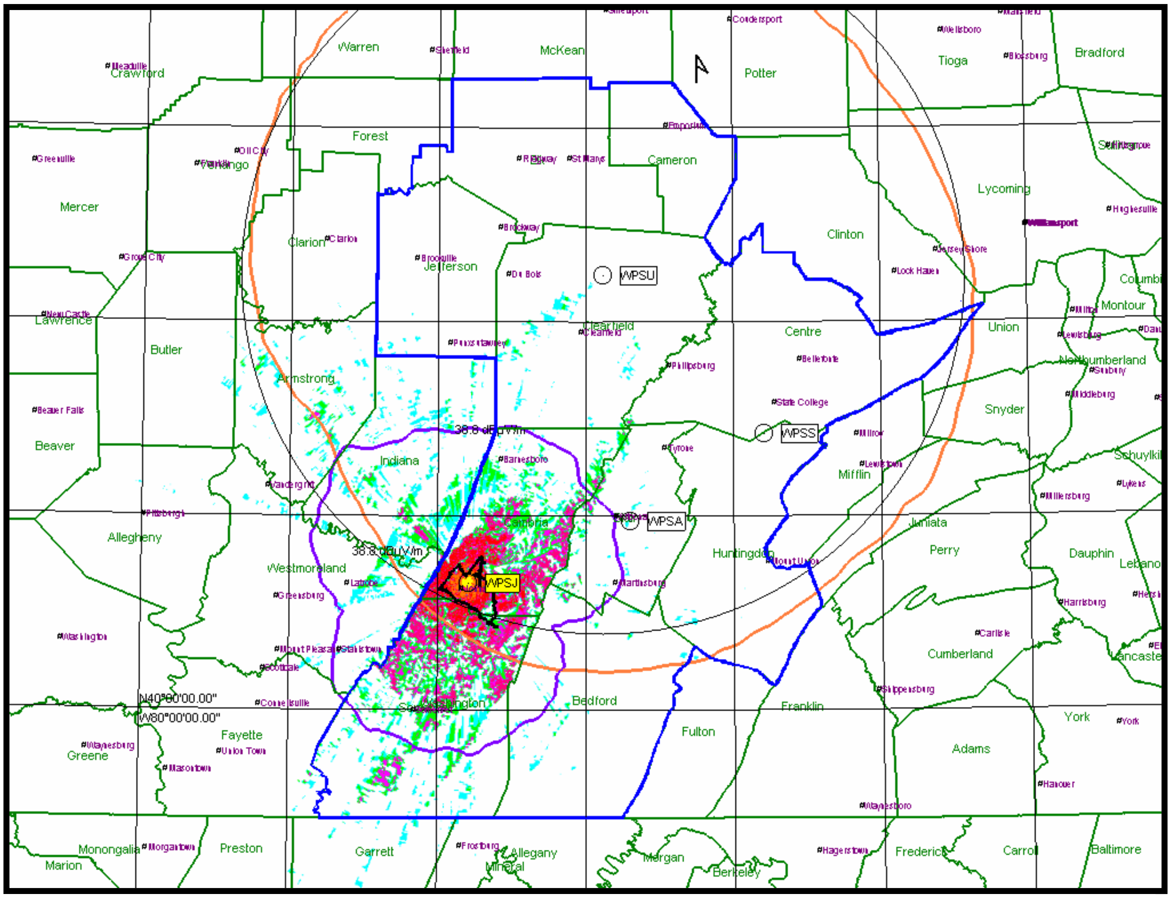

Figure 1 — Contour & Longley-Rice Performance of DTS Transmitter Serving City on DMA Boundary

If one considers a market in which all of the stations have single transmitters collocated at a central site, then a city such as shown in Figure 1 would have lacked real over-the-air service throughout the analog history of television broadcasting. The opportunity now exists to rectify that lack of service through the use of DTS. As can be seen in Figure 1, though, providing DTS service of a reasonable signal level to the outlying city will require provisions for contours to extend beyond the defined service boundaries – whether based on circles or DMAs. Examples of this sort abound.

Concern for delivery of service to hitherto-ignored communities leads to the proposition that the rules should provide one of two solutions. The preferable solution would have a rule that allows contours to extend beyond circle and/or DMA boundaries so long as the preponderance of population predicted to be served falls within the selected boundary type. An alternative solution would be for the rules to include a provision for waivers to be granted by the Commission's staff upon a straightforward showing that the bulk of the population predicted to be served falls within the requisite boundary or that the population in and around the boundary area is otherwise underserved.

Variable D/U Ratios

MSTV proposes a number of changes in the desired-to-undesired (D/U) ratios and the methodology used to determine the presence of interference to study cells when conducting the Longley-Rice analysis defined in OET Bulletin No. 69 and built into the TV_Process program used by the Commission's staff and by the industry at large. Among the changes proposed by MSTV is the use of different D/U ratio threshold values depending upon the received signal levels predicted for the desired signals. MSTV suggests using the "weak," "moderate," and "strong" signal levels defined in the ATSC "Recommended Practice: Receiver Performance Guidelines" (A/74) and using the related D/U ratios included therein. For received signal levels between the defined values, linear interpolation would be applied to determine the appropriate D/U ratio to be used. When a "strong" desired signal level was predicted to occur at a particular study cell location, the antenna directivity normally included in the calculation of interference would be eliminated, based on an assumption that indoor reception with largely non-directional receiving antennas would occur at such locations. Because of the signal level relationships involved, in practice, these changes would only have an effect when analyzing in-market adjacent channel operations.

In principal, we concur in the approach proposed by MSTV. We do have some reservations, however, with respect to one detail of the suggested alterations in method and with their overall application. Turning to the detail item first, if the occurrence of a strong signal level will trigger the assumption of indoor reception and the consequent elimination of receiving antenna directivity from the calculation, then the effects of such a scenario should be included in their entirety. Indoor reception entails losses in field strength from those predicted outdoors at the standard height of 9.1 meters (30 feet). Such losses include the well-known reduction in field strength from decreasing receiving antenna height from 9.1 m to 2 m (about 6 feet), the reduction in received signal level from using a non-directional antenna instead of the assumed outdoor antenna having 10 dB gain, and the building penetration losses from the RF energy passing through roofs, walls, ceilings, floors, siding, metalized insulation, and the like. These losses can be approximated as 10 dB for the reduction in antenna height, 10 dB for the loss in receiving antenna gain, and 20 dB for building penetration losses – totaling 40 dB. Clearly, if indoor reception is to be assumed at a given location, then the corresponding receiver performance at the signal level actually reaching the receiver must be used with respect to the D/U ratio, as opposed to that corresponding to the signal level when receiving with an outdoor antenna at the standard height.

Thus, if the MSTV proposal is adopted, an additional modification of the analysis methodology becomes necessary for a correct calculation to be achieved. The modification entails determining the D/U ratio to be used through application of a reduction in the received signal level by a prescribed amount when the elimination of antenna directivity is triggered in the calculation. For example, if the field strength of the desired signal calculated at a particular study cell would result in a “strong” received signal level, then the use of antenna directivity would be eliminated from the interference calculation and the D/U ratio threshold for a “weak” desired signal level might be applied. This relationship derives from the “strong” level being – 28 dBm and the “weak” level being – 68 dBm, a difference of 40 dB. If some other value were adopted to represent the total losses resulting when switching from outdoor- to indoor-reception assumptions, then the appropriate D/U ratio threshold would be found through the same interpolation process already proposed in the MSTV method. The important point is not to make a change in assumptions in one part of the interference determination without making the corresponding change in assumptions in the other parts of the calculation.

Another important consideration with respect to the proposed MSTV methodology changes is that, if they are to be applied to interference analyses involving DTS operations, they should be applied as well to analyses involving only single-transmitter operations. If the underlying reasons for the MSTV proposal are correct, then such application is necessary to properly account for interference between stations when their adjacent channel, single transmitters are not collocated but are close enough to one another that interference within their “strong” signal level zones becomes a possibility.

There are a number of such situations around the country, in which spectrum crowding prevented adequate separations in the original allotments to the stations or in which one of the stations moved its facilities under the provisions of the Commission's rules and the current interference analysis methods. Going forward, these situations must be properly identified and managed if additional interference between stations is not to occur as stations move to higher power operation than has been the general practice in the past. Indeed, our experience shows that the interference that occurs in such situations often can be mitigated through the use of DTS, careful network design, and proper interference analysis methods.

Interference Calculations

Among those commenting on the subject, there is general agreement that some form of aggregation of the interference from the several transmitters in a DTS network should be applied in determining the undesired signal level to be used in D/U ratio calculations. We agree with this approach and, in our previous submissions to the Commission, have offered several suggestions as to how this might be accomplished. One new suggestion was made in this proceeding in the comments of Cohen, Dippell, and Everist, P.C. (CDE), and we believe that it is the correct method. In particular, CDE suggests the use of a "root-sum-square" (RSS) calculation for the aggregation of signals when undesired signal levels are aggregated for first-adjacent channel interference evaluation. The justification for using the RSS method is that "there is virtually no possibility that the receiver will **coherently** sum interfering signals from two undesired transmitters; summing the undesired signals would be overly pessimistic." (Emphasis added.)

While we agree with CDE with respect to adjacent channel interference determinations, we believe that the RSS method also should be applied to co-channel interference evaluation. The reason is the same as given by CDE to justify use of RSS for adjacent channel cases: the receiver will not **coherently** sum interfering signals from two undesired transmitters. To see why this is the case, what is required to make signals sum coherently must be understood. There are two factors necessary for coherence that would justify a simple summation of the powers of the signals: the symbols arriving at a

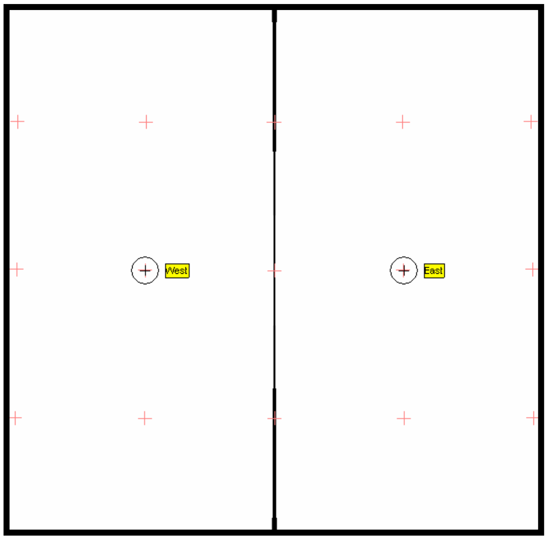

Figure 2A — Distributed Xmtrs with Equal Emission Times

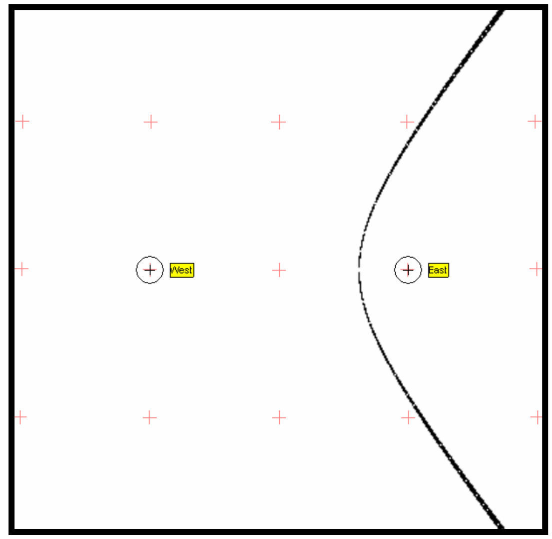

Figure 2B — Distributed Xmtrs with Unequal Emission Times

receiver would have to be the same, and the RF signals would have to be phase aligned. Neither of these conditions can be expected to occur in practical circumstances.

For the symbols to be aligned, the signals from the respective transmitters must arrive at the receiver at the same time. The time of signal arrival from any transmitter is determined by the distance of the receiver from that transmitter, the speed of light (and other electromagnetic emissions), and any delay interposed between the signal source and the transmitter output. If two transmitters emit their signals at precisely the same time, then the locus of points at which the signals will arrive at the same time lies along a straight line perpendicular to the line between the transmitters and intersecting the line between the transmitters at a point equidistant from them. This can be seen in Figure 2A. Since symbols in the ATSC 8-VSB system have a period of 92.9 ns, and given the speed of light, the width of the line in Figure 2A at the intersection point is 27.9 meters (about 91 feet) if displacement by a full symbol period is assumed to be required to spoil coherence between the signals (a conservative assumption). The band spreads slightly as the distance from the intersection point increases, as the shapes of the two sides of the band in reality are a pair of very shallow hyperbolas. Thus, a receiver would have to be located within a band less than 28 meters wide at its narrowest (and slightly less than 40 meters – about 130 feet – wide 100 miles from the intersection point) in order for the symbols of the signals from the two transmitters to be time aligned at their arrival.

Even if the receiver fell within the very narrow region just defined, because of the anomalies of propagation, the likelihood that the signals also would be RF phase-aligned is infinitesimal. Accordingly, it can be stated with considerable certainty that coherence between the signals is not possible from the standpoint of their interference-causing potential. With respect to their effect on a receiver tuned to another station on the same channel, the incoherent signals will be noise-like in nature. Therefore, it is appropriate to accumulate their power levels using the RSS method, as is applied to any case of the addition of noise powers.

For completeness, the case in which a time delay is inserted into the signal path of one of a pair of transmitters is instructive and is shown in Figure 2B. It can be seen that the locus of points having equal arrival times is hyperbolic (actually bounded by a nested pair of hyperbolas). At the point of its crossing the line between the transmitters, the hyperbola will have a width of the same 27.9 meters as in Figure 2A. It will widen somewhat as it extends farther from the line between the transmitters, but, just as in the case of equal transmitter emission times, the chances of RF phase alignment at the receiver are infinitesimal. As a result, there can be no coherence of the signals and the result is the same as in the case depicted in Figure 2A.

At first thought, it might seem that a receiver adaptive equalizer somehow could treat the signals from multiple, interfering, co-channel transmitters and make them appear coherent with one another. It must be remembered, however, that, in a co-channel interference analysis, the desired signal must be 15 dB or more above the noise, including noise caused by interfering signals. With that sort of amplitude separation, the adaptive equalizer will be able to train only on the strong, desired signal and will not be able to process any signals that are not themselves coherent with the desired signal. For the addition of any interfering signals to matter, each must be more than 15 dB below the amplitude of the desired signal, or it would be determined to cause interference on its own. Thus, the addition of signals from several transmitters can only matter when all of them are greater than 15 dB below the desired signal, at which point the adaptive equalizer clearly will train on the desired signal and treat the completely incoherent (from the desired signal) undesired signals as just so much noise. Consequently, use of an RSS summation is the appropriate choice in the case of co-channel interference evaluation, just as in the adjacent channel case.

Given this analysis, we agree with CDE that the RSS method is the correct one to apply to the summation of signal powers from multiple transmitters, but we propose that it be applied to the determination of the undesired signal levels from a DTS network for all channel relationships.

Emission Masks

Harris Corporation, in its comments to the NPRM, generally supports the Commission's proposal to apply the existing maximum power and emission mask requirements to DTS transmitters. It suggests, however, that the emission mask requirements can be relaxed for "very low power transmitters, more likely to be used in secondary services, such as DTV boosters and translators." It then gives the example of a transmitter licensed as part of a primary service "with a power of 10 watts, in the repeater/translator class." It asks, "why not allow that particular transmitter to have [a] relaxed emission mask…[?]"

While we agree that such an emission mask relaxation might be appropriate when low power transmitters are used as translators or as stand-alone LPTV operations in areas of low population, we are concerned about such a relaxation when such transmitters are located in dense RF environments with significant populations. What would happen if 20 stations in a very large market decided to build a common DTS network with all of their transmitters collocated? Depending upon how the relaxed mask was characterized, there might be a significant increase in the noise floor that could affect all of the stations. Of course, it could be argued that, in such a case, masks that are more stringent could be used, but policing such a decision could become an unwieldy task. Conversely, when the signal levels get to be too low, it becomes difficult even to measure them, let alone for them to have any interference impact after they have been radiated.

To put this issue into context, we did some research on the cost of various configurations of filters that could be used in the circumstances described. In general, filters used today were designed for higher power applications and are more expensive than they need be (about $4,000). Filters having a relaxed characteristic that were designed for low power operation are in the neighborhood of one-quarter as much (a bit over $1,000). If a filter were designed specifically for low power operation but with a more stringent mask shape, the cost is likely to be in the range of double the cost of the low power, relaxed mask filter and half the cost of the moderate power, more stringent filter (somewhere over $2,000). Thus, the savings that might be obtained with the relaxed mask might be approximately $1,000 per transmitter.

The question then must be asked whether, in the grand scheme of things, such a relatively small savings is worth the potential for increased interference. In our opinion, spectrum mask relaxation of the sort described should be limited to cases in which the transmitters are in areas of low population and low RF density, or there should be a showing from the applicant to use such relaxed filters that unacceptable interference will not be caused to neighboring stations through their use.

Standards and Patents

In our initial comments, we indicated our support for the Commission not adopting any particular standard for the synchronization of transmitters in a DTS network. We further proposed that the Commission should not get involved in the matter of patents and the undertaking of "reasonable and non-discriminatory" (RAND) terms for their licensing. After reviewing the comments of MSTV on this matter, we hereby clarify that we agree "in the event the Commission elects to establish a DTS standard, it should insure that any entities holding patents essential to the new standard have committed to licensing the technology on a fair and nondiscriminatory basis." When the FCC adopted the ATSC Digital Television Standard in 1996, it obtained assurances from the ATSC that RAND statements had been obtained by the ATSC from all known holders of intellectual property in the standard. Should the Commission, at some future time, adopt a standard for DTS transmitter synchronization, following a procedure similar to that used in 1996 would address our concerns that the FCC should leave to industry standards bodies the responsibility for dealing with such matters in detail.

Revisions to OET-69

It is generally understood and agreed by all parties commenting on the subject that the methodology defined in OET Bulletin No. 69 will have to be extended to make it fully useful for analysis of interference from and to DTS networks. Implicit in that conclusion is that the CDBS database and the application forms that serve as input to it (i.e., Forms 301, 302, and 340) also will require modification. The question to be answered is what form these modifications should take and how extensive they need be.

Our experience designing DTS networks, to date, has been based upon use of a modified version of the TV_Process program that applies the methodology of OET-69 for the Commission and for the industry. We find that it yields the raw data needed properly to evaluate the aggregated interference to other stations from multiple transmitters. With that data and additional processing carried out in our own supplemental routines, we have been able to determine interference to other stations in accordance with the interim policy adopted by the Commission for DTS authorizations. We see no reason that it cannot be further extended easily to evaluate interference in the other directions, although doing so will require somewhat more modifications than already have been accomplished.

In their comments in this proceeding, Cohen, Dippell, and Everist, P.C. suggest a number of changes that, while not necessary to making TV_Process work for DTS analysis, seem as though they should make the task somewhat easier. In particular, the suggestion to "align the grid on cardinal values of latitude and longitude" seems appropriate. The conversion to NAD-83 values from the current use of NAD-27, as suggested by CDE, also makes sense from a number of perspectives. First, tower locations are stored in the Commission's database in NAD-83, requiring constant value conversions by those filing applications in the broadcast services. Second, the terrain database on which TV_Process operates is natively in NAD-83, requiring conversion to NAD-27 every time that TV_Process is run. These wastes of time and of processing overhead could be eliminated by adoption of the CDE proposal.

Of course, the changes proposed by CDE also would affect the results obtained for interference between stations. Existing authorizations would have to be "grandfathered" in the event of adoption of the CDE proposals, since there are likely to be some that would no longer meet the *de minimis* requirements if the study cell structure were changed. Nevertheless, over the long term, the CDE suggestions seem sensible and should contribute to improved efficiency of the interference evaluation and application processes.

In several places in its comments, MSTV offers to work with the Commission in developing a revised methodology for consideration of variable D/U ratios and for aggregation of signals on the same frequency. We make the same offer. We have significant experience dealing with the issues surrounding interference analysis in a multiple-transmitter environment, and we have software tools that can show the sorts of results that will be produced when the Commission's own software is modified for the task. Indeed, we already have offered to the FCC staff the use of our software tools with no compensation required.

Most important in developing the updated evaluation processes and software tools to enable interference analysis in a DTS environment is that the development process be open and transparent. There should be opportunity for those knowledgeable in this area to provide input as the development is planned and takes place. If the types of changes in the analysis routines proposed by others are to be adopted, there should be opportunities for testing of the software before it finally is adopted by the Commission. This will allow feedback on any issues found and reduce the need for corrections and re-releases of software programs.

The Merrill Weiss Group LLC again commends the FCC for moving forward with the NPRM on Distributed Transmission Systems technologies and thanks the Commission for its consideration of these comments.

Respectfully submitted,

Merrill Weiss Group LLC

By: ___/s/ S. Merrill Weiss____

S. Merrill Weiss
President

Merrill Weiss Group LLC
227 Central Avenue
Metuchen, NJ 08840-1242
Phone: 732 494 6400
Fax: 732 494 6401
e-mail: merrill@mwgrp.com